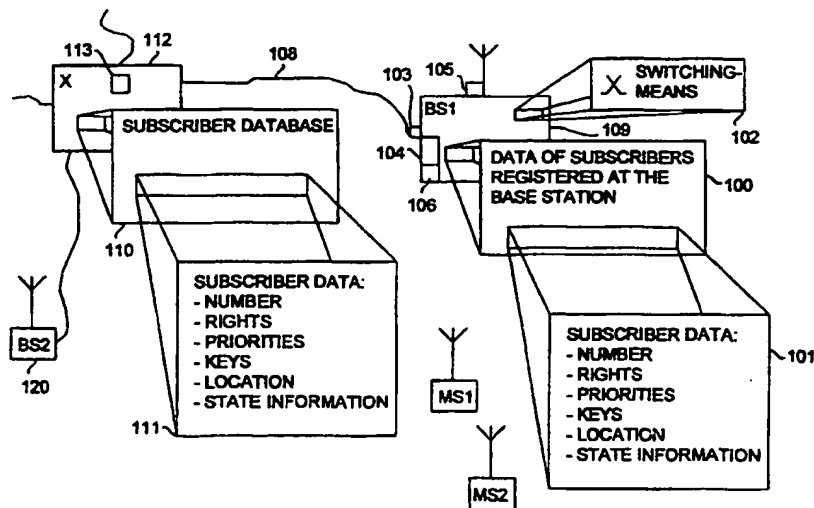




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(54) Title: PROVIDING SERVICE IN MOBILE COMMUNICATION SYSTEM



(57) Abstract

The invention relates to a method, a mobile communication system and a base station for providing service in a mobile communication system comprising an exchange (X, 112), base stations (BS1, BS2, 109) with coverage areas, mobile stations (MS1, MS2), and a centralized database (110) for storing subscriber data (111) of mobile stations (MS1, MS2) located within the service area of the system. In order for the connection establishment to be expedited, the base station (BS1) maintains a database (100) containing the subscriber data (101) of mobile stations (MS1, MS2) registered at the base station by fetching the subscriber data of the mobile station from said centralized database (110) when the mobile station registers at the base station (BS1); the mobile station (MS1) sends a service request to the base station; the base station verifies the access right of said mobile station from the database (100) maintained at said base station; if said mobile station has the right of use, the base station (BS1) provides (102) the service requested by the service request.

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## Providing service in mobile communication system

5           The invention relates to a method, a mobile communication system and a base station for providing service in a mobile communication system comprising an exchange, base stations with coverage areas, mobile stations, and a centralized database for storing subscriber data of mobile stations located within the service area of the system.

10           In some mobile communication and mobile telephone networks of the prior art, subscriber information, i.e. the subscriber database, is stored in a centralized manner in one network element, usually in an exchange or a subscriber database connected to it. In a larger  
15           network, the subscriber data may also be stored in a decentralized manner in so-called home mobile telephone exchanges and visited mobile telephone exchanges or visitor databases. This is the case, for example, in GSM mobile communication systems.

20           The drawback of such a system based on centralized registers is that it takes a very long time to establish a connection between mobile stations located within the coverage area of one base station. This is because the location data of the mobile stations must  
25           be requested and their subscriber data must be checked from a centralized register located far from the base station within whose area the mobile stations or subscriber stations between which the connection is to be established are located. Interrogation of data from a  
30           register located at a great distance, even behind other exchanges or network elements, is slow and uncertain, as the telecommunication connections may be broken. In the above-described large mobile telephone networks, where the subscriber data are stored in separate,  
35           centralized home and visitor location registers or

corresponding exchanges, interrogation of subscriber data from the centralized subscriber database takes a considerable amount of the call establishment time. The interrogation time becomes easily longer than 1 s. However, authorities using mobile telephone systems, for example, require that the entire call establishment procedure within the area of one base station must not take longer than 300 ms even though the subscriber data of the subscriber are verified. In this kind of prior art solution, the subscriber data interrogation time is considerably prolonged by the data transmission delay between the exchange and the base station, as it is often not economically possible to use sufficient transmission capacity between them. Interrogation of subscriber data is particularly important, as it involves authentication of the subscriber. Authentication of the subscriber means that it is examined whether the subscriber and/or the mobile station are/is allowed to use the network services.

Another solution of the prior art is that in small systems comprising one base station, the subscriber data are stored in the base station. This is implemented in such a manner, however, that base stations possibly interconnected via speech paths cannot exchange subscriber data with each other.

The drawback of this solution is that when subscriber data are to be updated, they cannot be updated at each base station of the network. In addition, it is not possible to construct larger networks by this technology: if base stations are interconnected directly without any exchanges, communication between the base stations takes up more interface capacity of the base stations than maintenance of the actual radio channels. The problem is even more serious when a larger number of base stations are interconnected.

Yet another solution of the prior art is a so-called fallback function of the base station. This kind of a base station does not have a subscriber database of its own, but it can switch calls between subscribers located within its coverage area.

The disadvantage of this solution is that the subscriber data of subscribers or mobile stations which are about to register at the base station or wish to establish a call cannot be verified or authenticated. It is therefore possible that an illegal subscriber starts to communicate using the resources of this base station.

The prior art solutions described above are not suitable for use in mobile telephone networks where calls must be established rapidly but where a large number of subscriber data are needed, e.g. in private mobile radio (PMR) networks used by authorities. The subscriber data include subscriber-specific information on the rights of each subscriber to the network services, on priorities, security codes, operating state, group call groups, and other data. Furthermore, it should be possible to provide a very large permitted operating area for a subscriber in such a PMR network used by authorities: e.g. a whole country or even a larger area. On the basis of the above, it is thus evident that the prior art solutions described do not meet the requirements set by large mobile communication networks or mobile telephone networks, typically PMR networks used by authorities, which require rapid establishment of connection and rapid verification of subscriber data.

The object of the present invention is to solve the problems associated with the above-described solutions of the prior art. It is an object of the present invention to provide a mobile telephone network

which is capable of rapid establishment of connection and verification of subscriber data and which may be extremely large, covering for example a whole country. In addition, it must be possible to update the subscriber data of such a network flexibly and in a centralized manner.

This new type of method for providing service in a mobile communication system is achieved with a method according to the invention, which is characterized in that the base station maintains a database containing the subscriber data of mobile stations registered at the base station by fetching the subscriber data of a mobile station from said centralized database when the mobile station registers at the base station; the mobile station sends a service request to the base station; the base station verifies the access right of said mobile station from the database maintained at said base station; if said mobile station has the access right, the base station provides the service requested by the service request.

The invention also relates to a base station comprising a transceiver unit, an interface unit for connecting the base station through telecommunication connections to the exchange of the mobile communication system. The base station according to the invention comprises a database for storing subscriber data of mobile stations registered at the base station, means for verifying from said database the access right of a mobile station which sent the service request to the base station.

The invention further relates to a mobile communication system comprising: base stations, an exchange, a database for storing, in a centralized manner, subscriber data of mobile stations located within the service area of the system. The mobile com-

munication system according to the invention is characterized in that said base station comprises a database for storing the subscriber data of mobile stations registered at the base station, means for verifying from  
5 said database the access right of a mobile station which has sent a service request to the base station.

The invention is based on the idea that in a mobile communication system comprising a centralized database containing subscriber data, the base stations  
10 maintain smaller databases for storing the subscriber data of the mobile stations registered at the base station in question. When a mobile station wishes to use a telecommunications service offered by the system, e.g. to establish a call, the subscriber data of this mobile  
15 station are checked from the database of the base station in question, whereafter the base station sets up the connection. The connection establishment is expedited particularly in a situation where a connection is to be set up to a mobile station registered at the  
20 same base station.

An advantage of such a method for providing service in a mobile communication system, a mobile communication system and a base station is that when a call  
25 is made within the area of one base station, it is not necessary to request the subscriber data needed for establishing the call from the exchange or, via the exchange, from the centralized database of the system. Particularly most of the connections which are established between authorities and require rapid communication fall within the area of one base station. Examples  
30 of such connections are those needed by a police patrol on duty, by a fire brigade in the event of a fire, and by an ambulance on the scene of an accident.

The invention allows a call to be established  
35 within the area of one base station more rapidly than

if the subscriber data had to be requested every time from a centralized database. This advantage is particularly apparent in systems where most of the traffic takes place within the area of one base station.

5 An example of such a system is the police radio system, in which the police make a large number of calls in quick succession within the area of only one base station. The fastness of connection establishment is naturally very significant in police use and other  
10 emergency use.

Another advantage of the method according to the invention is that the base station is able to serve subscribers remaining within its area even when the connection to the exchange is broken for one reason or  
15 another. This is a very important feature especially in PMR networks used by authorities, where it may be of utmost significance to have functioning connections, and where attempts may be made to intentionally disturb or even disconnect data link connections between, for  
20 instance, the base station and other parts of the system.

Yet another advantage of the method according to the invention is that the decentralized databases at the base stations of the mobile communication system can  
25 be maintained so that they constantly contain the new subscriber data of the mobile stations registered at these base stations.

Still a further advantage of the invention is that it renders it possible to construct larger networks  
30 than the prior art solution in which the base stations did have databases, but the base stations were interconnected through telecommunication connections. This enables the construction of extremely large mobile telephone networks for the use of national authorities.



Yet another advantage of the invention is that it allows the subscriber data of mobile stations communicating within the area of the base station to be verified and authenticated, and safe connections between mobile stations located within the coverage area of the base station to be established even in cases where the telecommunication connections between the base station and the exchange are broken.

In the following, the invention will be described in greater detail with reference to the accompanying drawings, in which

Figure 1 is a block diagram of a mobile communication system according to the invention with subscriber databases,

Figure 2 is a signalling and event diagram of the registration of a mobile station at a base station,

Figure 3 is a signalling and event diagram of connection establishment within the service area of a base station.

Figure 1 is a block diagram of a mobile communication system according to the invention with subscriber databases. The mobile communication system comprises a base station BS1, at which a mobile station MS1, which is a subscriber station (i.e. a mobile or radio telephone, for example), is registered.

The base station BS1, BS2, 109 comprises a database 100 for storing the subscriber data 101 of subscribers registered at the base station BS1. The subscriber data may include, for example, the number or other identifier of the subscriber, the rights belonging to the subscriber, i.e. mainly information on the functions and services which the mobile station in question is entitled to use. In addition, these services or some of them are associated with a certain priority. The subscriber data further include encryption keys,

used in the communication between the base station and a mobile station for encrypting traffic taking place on a radio path. The subscriber data also include the location of the mobile station, e.g. with an accuracy of a base station or a location area. In addition, the subscriber data include information on the state of the mobile station, i.e. on whether the subscriber station in question is switched on, and whether the mobile station communicates on a traffic channel or whether it only listens to a control channel. The state information also includes, for example, information on ongoing group calls.

The base station BS1 further comprises switching means 102 for establishing connections between mobile stations MS1, MS2 registered at the base station. The base station BS1, BS2 also comprises at least one transceiver unit 105 connected to an antenna. The transceiver unit 105 communicates with mobile stations MS1, MS2 via a radio path.

The base station also comprises means 104 for verifying, from the database 100 of the base station, the access right of the mobile station MS1 that sent the service request to the base station, said database containing the subscriber data 101 of the mobile stations MS1, MS2 registered at the base station.

In addition, the base station BS1, BS2 comprises means 106 for requesting the subscriber data 111 of a mobile station MS1 registered at the base station from a centralized database 110.

The base station BS1, BS2 further comprises an interface unit 103 for connecting the base station through telecommunication connections 108 to the exchange 112, X of the mobile communication system.

The exchange 112 shown in Figure 1 comprises a database 110 for storing, in a centralized manner, the

subscriber data 111 of mobile stations located within the service area of the mobile communication system. The mobile communication system may comprise means 113 for erasing the subscriber data of a mobile station from the database of the base station BS2, 120 at which the mobile station MS1 is no longer registered, responsive to the request 106 for subscriber data made by the base station BS1, 100 at which the mobile station MS1 is registered. The means 113 are located, for example, at the exchange 112 of the mobile communication system or in connection with the above-mentioned centralized database 110.

Figure 2 is a signalling and event diagram of the registration of a mobile station MS1 at a base station BS1. The MS1 is a new subscriber registering at the area of the base station BS1 by transmitting a registration message 201. After that, the base station BS1 may check 202 whether its database 100 already contains the subscriber data of the subscriber MS1. If the database does not 203 contain these subscriber data, the base station BS1 sends 204 a registration message to the exchange X of the mobile communication system. The exchange fetches 205 the data of the mobile station or subscriber from the centralized database 110 and simultaneously checks the location of the mobile station. If the mobile station has changed its base station, i.e. moved away from the service area of a base station BS2 to the service area of a new base station BS1, the exchange X sends 206 a remove message to the old base station BS2. Responsive to this message, the old base station BS2 removes 207 the subscriber data of the mobile station MS1 from its database.

On receiving a registration message from the (new) base station BS1 and verifying 205 the subscriber data of the mobile station, the exchange sends 208 the

subscriber data of the mobile station as a data message to the (new) base station BS1 which sent the registration message. The base station BS1 stores the subscriber data 101 of the mobile station in its database 100.

5      Thereafter the base station BS1 sends 209 an acknowledge message to the mobile station. By this message, the base station informs that the registration of the mobile station has succeeded at the base station.

10      Figure 3 is a signalling and event diagram of connection establishment within the service area of the base station BS1. A mobile station MS1, e.g. a mobile telephone, wishes to establish a telecommunication connection, e.g. a call, to a B-subscriber, i.e. to another mobile station MS2. The mobile station MS1 sends a connection establishment request 302, comprising the  
15      identifier of the B-subscriber, i.e. the identifier of the other mobile station. The base station BS1 receives this connection establishment request 302 and checks 303 the subscriber data 101 of the calling subscriber, i.e.  
20      the mobile station MS1, from its database 100 according to the invention, and performs the necessary verifications, and authentication and authorization of the subscriber. At the same time, the subscriber data of the receiving B-subscriber can also be checked from the  
25      database 100. If the base station BS1 has 304 a free channel which the mobile station can use, it sends a channel command 305, by which it commands the mobile stations MS1, MS2 to move to the desired channel(s). Thereafter the base station BS1 sends 306 information  
30      to the exchange X on the allocation of the channel(s). The exchange X stores 307 these data in its database or in the centralized database of the system.

35      When the above-described method of the invention is used, the time it takes to establish a call is shortened approximately from a few seconds to a few

5 milliseconds. Such an improvement is possible, as data can be very rapidly retrieved from the relatively small subscriber data table in the database 100 of the base station BS1, implemented e.g. by means of a rapid RAM memory, as compared with fetching the subscriber data from a large centralized subscriber database over an uncertain data link, in which case transmission errors and transmission delays, for example, cause a significant additional delay.

10 The drawings and the description relating to them are intended merely to illustrate the inventive concept. In its details, the method for providing service in a mobile communication system, the mobile communication system and the base station according to  
15 the invention can be modified within the scope of the claims. Although the invention has been described above mainly in connection with mobile telephone systems, it may also be used in other kinds of mobile communication systems.

## Claims

1. A method for providing service in a mobile communication system comprising an exchange (X, 112),  
5 base stations (BS1, BS2, 109) with coverage areas, mobile stations (MS1, MS2), and a centralized database (110) for storing subscriber data (111) of mobile stations (MS1, MS2) located within the service area of the system, c h a r a c t e r i z e d in that  
10 the base station (BS1) maintains (Fig.2) a database (100) containing the subscriber data (101) of mobile stations (MS1) registered at the base station by fetching (204) the subscriber data of a mobile station from said centralized database (110) when the mobile  
15 station registers (201) at the base station (BS1);  
the mobile station (MS1) sends a service request (302) to the base station;  
the base station verifies (303) the access right of said mobile station from the database (100)  
20 maintained at said base station;  
if said mobile station has the access right, the base station (BS1) provides the service requested by the service request (302).
2. A method according to claim 1, c h a r a c -  
25 t e r i z e d in that the step in which the base station maintains (Fig. 2) a database (100) comprises the following steps:  
if the subscriber data of the mobile station which sent the registration message are not (203)  
30 contained in the database (100) of the base station, the base station (BS1) requests (204) the subscriber data (111) of said mobile station from the centralized data-  
base (110) of the system,  
responsive to this request, said subscriber  
35 data are sent (208) to said base station (BS1),

said base station (BS1) stores said subscriber data in its database (100).

3. A method according to claim 2, characterized in that, responsive to the request (204) made by the base station for subscriber data from the centralized database, another base station (BS2) is requested (206) to remove the subscriber data of said mobile station from its database and, responsive to this request, the other base station (BS2) removes the subscriber data of said mobile station from its database.

4. A method according to claim 2 or 3, characterized in that on receiving the subscriber data of said mobile station, the base station (BS1) sends (209) an acknowledge message to the mobile station (MS1) which sent the registration message (201).

5. A method according to claim 1, characterized in that said service request (302) is a connection establishment request, responsive to which the base station switches (102) a telecommunication connection from said mobile station (MS1) to the destination (MS2) defined in the connection establishment request (302).

6. A method according to claim 5, characterized in that when switching (102) the telecommunication connection from said mobile station (MS1) to the destination (MS2) defined in the connection establishment request (302), the base station (BS1) commands (305) said mobile station to move to the desired radio channel.

7. A method according to claim 5 or 6, characterized in that when switching (102) the telecommunication connection from said mobile station (MS1) to the destination defined in the connection establishment request (302), the base station (BS1) sends (306) to the exchange (X) information on

said mobile station, said destination, and the radio channel to be used.

5 8. A method according to any one of claims 5 to 7, c h a r a c t e r i z e d in that the destination defined in the connection establishment request (302) is another mobile station (MS2) registered at said base station (BS1).

9. A method according to claim 8, c h a r a c - t e r i z e d by comprising the following steps:

10 a mobile station (MS1) registered at the base station sends (302) a connection establishment request to the base station for requesting establishment of a connection to another mobile station (MS2),

15 the base station verifies the access right of said mobile station (MS1) from the database (100) maintained (Fig. 2) at said base station (BS1),

the base station detects that the subscriber data of said other mobile station (MS2) are stored in the base station (100) of said base station (BS1),

20 the base station establishes (102) the desired connection between said one mobile station (MS1) and said other mobile station (MS2).

10. A base station (BS1, BS2, 109) comprising: a transceiver unit (105),

25 an interface unit (103) for connecting the base station through telecommunication connections (108) to the exchange (112) of the mobile communication system,

c h a r a c t e r i z e d in that the base station comprises

30 a database (100) for storing subscriber data (101) of mobile stations (MS) registered at the base station,

means (104) for verifying from said database (100) the access right of a mobile station (MS1) which  
35 sent the service request to the base station.



11. A base station according to claim 10,  
c h a r a c t e r i z e d in that it further comprises  
means (106) for requesting (204) the subscriber  
data (111) of a mobile station registering at the base  
station from the centralized database (110) of the  
mobile communication system.

12. A base station according to claim 10 or 11,  
c h a r a c t e r i z e d in that it further comprises  
switching means (102) for establishing connections  
between mobile stations (MS1, MS2) registered at the  
base station.

13. A mobile communication system comprising:  
base stations (BS1, BS2),  
an exchange (X, 112),  
a database (110) for storing, in a centralized  
manner, subscriber data (111) of mobile stations located  
within the service area of the system,

the system being c h a r a c t e r i z e d in  
that said base station comprises

a database (100) for storing the subscriber  
data (101) of mobile stations (MS) registered at the  
base station,

means (104) for verifying from said database  
(100) the access right of a mobile station (MS1) which  
has sent a service request to the base station.

14. A mobile communication system according to  
claim 13, c h a r a c t e r i z e d in that said base  
station comprises

switching means (102) for establishing  
connections between mobile stations (MS1, MS2)  
registered at said base station (BS1).

15. A mobile communication system according to  
claim 13, c h a r a c t e r i z e d in that it further  
comprises

means (113) for erasing the subscriber data (101) of a mobile station from the database (100) of a base station (BS2) at which the mobile station is no longer registered, responsive to the request (204) for subscriber data of the mobile station made (106) by a base station (BS1) at which the mobile station is registered.

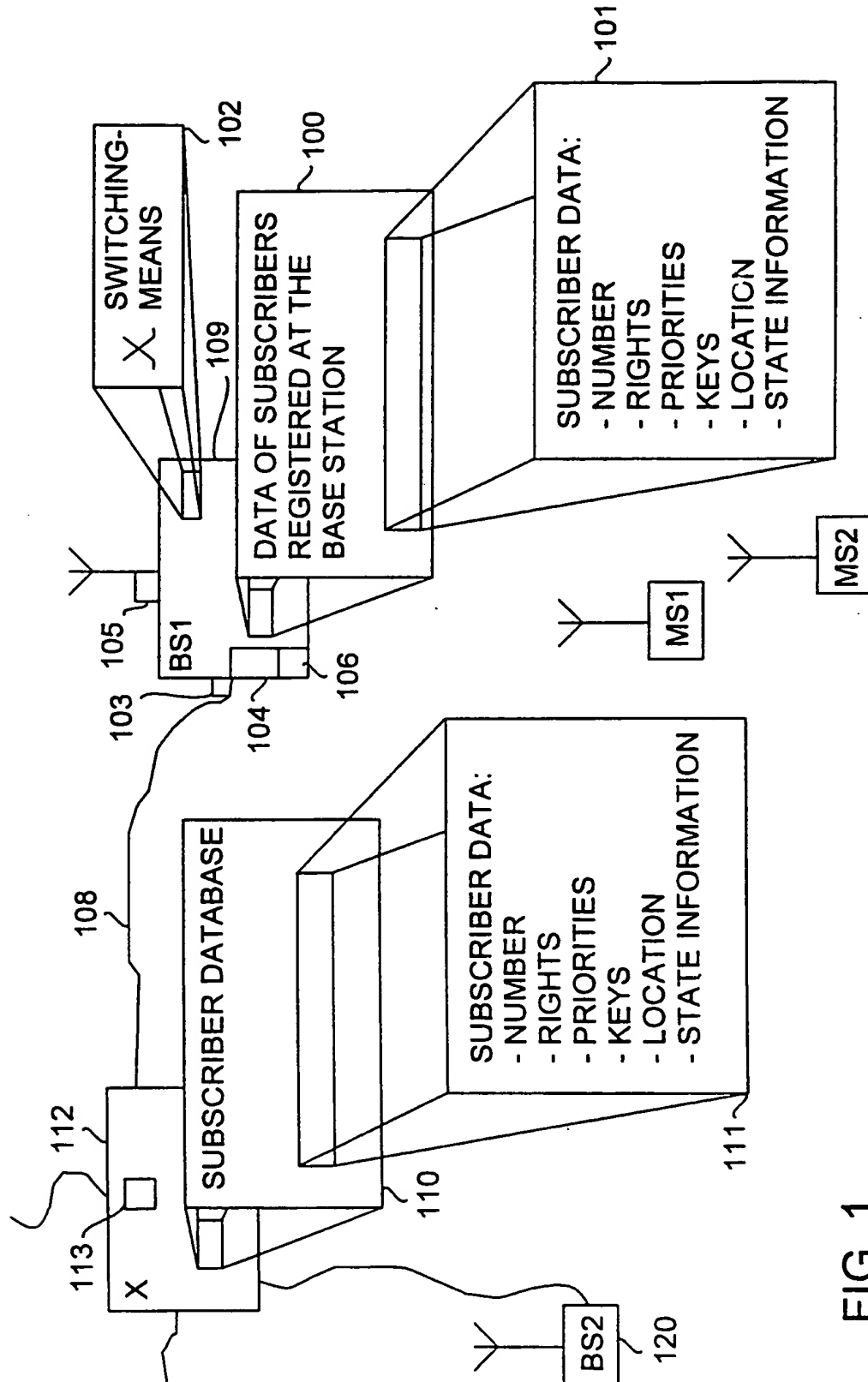


FIG. 1

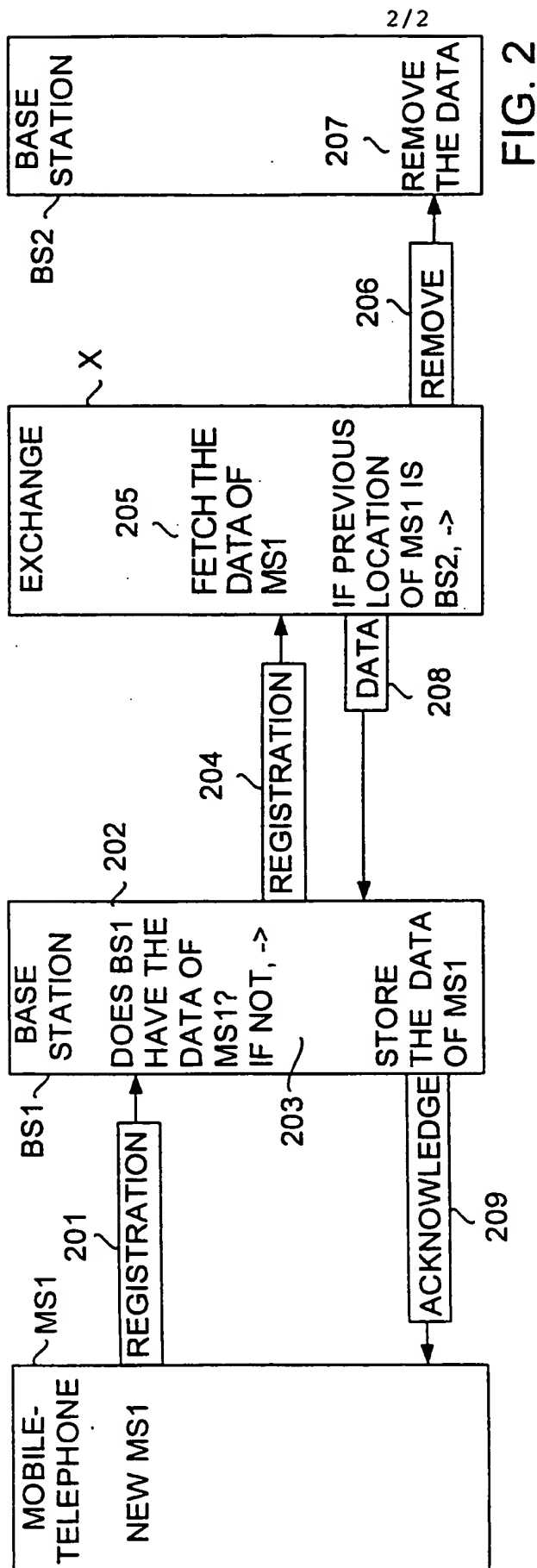


FIG. 2

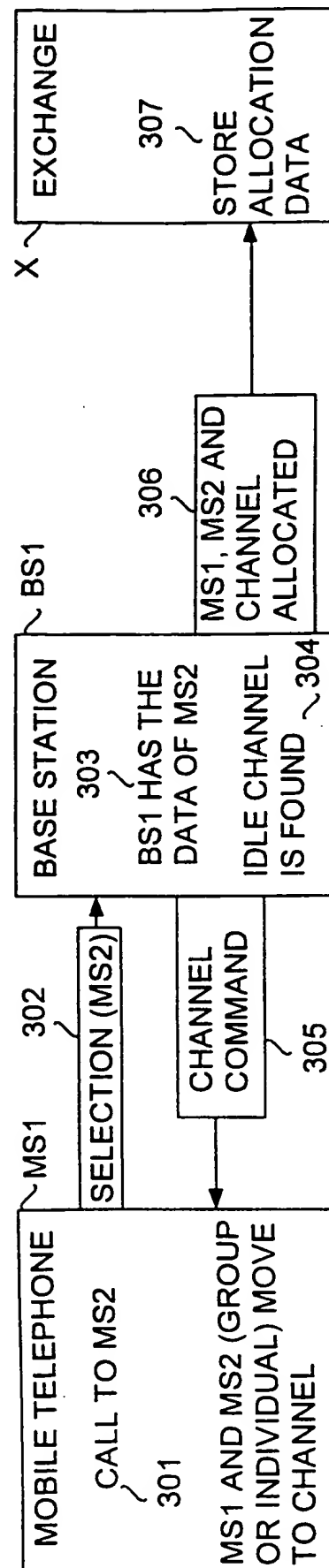


FIG. 3

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO, A1, 9311646 (ELECTRONIC DATA SYSTEMS CORPORATION), 10 June 1993 (10.06.93), page 12, line 28 - page 14, line 2 --	1-12
A	FI, B, 92007 (NOKIA TELECOMMUNICATIONS OY), 31 May 1994 (31.05.94), abstract, see claims -----	1-12

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents

- "A" document defining the general state of the art which is not considered to be of particular relevance
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

03/05/95

International application No.  
PCT/FI 95/00023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9311646	10/06/93	NONE	
FI-B- 92007	31/05/94	FI-A- 925646	24/02/94